Envisage Environmental Incorporated
P.O. Box 152, Richfield, Ohio 44286
Phone (216) 526-0990

REPORT NO. 91-1226 0304
COMPANY Hoover Company
TITLE Compliance
DATE 4-2-91

Question 5 - #1

THE HOOVER COMPANY
NORTH CANTON, OHIO

BOILER #3
PARTICULATE, SULFUR DIOXIDE
EMISSION EVALUATION

CONDUCTED - APRIL 2, 1991

Q5 - #1

SOURCE EVALUATION RESULTS

PREPARED BY

Envisage Environmental Incorporated

P.O. Box 152 Richfield, Ohio 44286
Phone (216) 526-0990

Envisage Environmental Incorporated P.O. Box 152 Richfield, Ohio 44286
Phone (216) 526-0990

April 24, 1991

Mr. Gareth P. Rich
Staff Works Engineer
The Hoover Company
101 East Maple Street
North Canton, Ohio 44720

Dear Mr. Rich:

The following report is the result of the particulate, and sulfur dioxide emission evaluation conducted on April 2, 1991 at the above location. Three (3) test runs were conducted on this date at the exhaust of Boiler # 3.

The results are true and accurate to the degree specified in the pertinent sections of the <u>Code of Federal Regulations</u>, in force at the time of testing.

I am looking forward to answering any questions you may have and assisting you in the future.

Respectfully submitted,

Tom E. Holder

Tom E. Holder
Environmental Engineer
ENVISAGE ENVIRONMENTAL INC.

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Environmental
Incorporated
P.O. Box 152 Richfield, Ohio 44286
Phone (216) 526-0990

INTRODUCTION

Envisage
Environmental
Incorporated
P.O. Box 152 Richfield, Ohio 44286
Phone (216) 526-0990

INTRODUCTION

On April 2, 1991, Envisage Environmental Inc. conducted an emission evaluation at The Hoover Company, 101 East Maple Street, North Canton, Ohio. Testing was conducted at the exhaust of Boiler # 3. Test parameters included particulate, and sulfur dioxide emissions.

The purpose of these tests was to determine compliance with applicable State and Federal Regulations concerning air pollution emissions. The boiler was monitored by Hoover Company and EPA personnel. Test parameters were in accordance with USEPA Reference Methods 1-6.

The Envisage testing team consisted of Messrs. John Krisak, Mark Gierke, and Greg Sinkovich. The Ohio EPA was represented by Mr. Andy Pasko, Air Pollution Control Division, Canton, Ohio. Mr. Gareth Rich, The Hoover Company, coordinated the testing.

Results are presented in this report for particulate, and sulfur dioxide emissions with the various velocity, volumetric and temperature measurements associated with these tests. Results in pounds per million BTU's has been calculated two (2) ways; Fuel Factor based on the analysis of the coal utilized during the test, and heat input based on the amount of coal burned during the test.

DESCRIPTION OF PROGRAM

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DESCRIPTION OF PROGRAM

The evaluation consisted of three (3) test runs, each one (1) hour in length. Six (6) sample points were used in each of the four (4) ports. Sample time per point was three (3) minutes each for a total sample time per run of seventy-two (72) minutes. Run # 3 included thirty-four (34) seconds of soot blowing with is normal operation. A diagram of the sample point locations is included in this report.

The samples were withdrawn from the gas stream isokinetically through seven (7) foot Pyrex lined probe. The entire length of the probe was heated and attached to a Method 5 sample train modified for the collection of sulfur dioxide. The hot box was set to maintain a temperature of 248 degree F. and the heated areas were monitored to ensure condensation did not form prior to the impingers. Exit gas temperature of the impingers was maintained below 68 degrees F. with an ice bath. The nozzle, probe and connecting glassware were cleaned before testing and at the conclusion of each test run with acetone. Leak checks of the pitot tube lines and the sample trains were all acceptable by EPA regulations. Cyclonic flow was less than ten (10) degrees.

The method 5 impinger train was modified by replacing the distilled water with the following: # 1 - 100 ml 80% Isopropanol, # 2 & 3 - 100 ml 3% Hydrogen Peroxide, # 4 - empty, # 5 - 200 grams silica gel. Analysis for sulfur dioxide was by the barium-thorin titration method.

Flue gas analysis was conducted by drawing an integrated air bag sample throughout each test run and analyzed with a Hays Republic Model 621A "Orsat" Portable Gas Analyzer. The average of at least three readings for each run were used in calculating the emission rates.

Description of Program - continued

Calibration of the equipment used, including the dry gas meter, orifice meter, and the "S" type pitot tube was conducted within 60 days of the test date. Copies of the data are included in this report.

All analytical procedures were performed in accordance with the methods specified in the Code of Federal Regulations, Title 40 Part 60, Volume 43. Blanks were collected and analyzed on the distilled water and acetone used in the evaluation. The residue from the distilled water was less than could be measured on a 0.1 milligram analytical balance and was considered zero. The acetone blank was recorded and incorporated into the results.

The example equations included in this report represents the data collected during Run # 1 conducted on this date.

TEST RESULTS
SUMMARY

Envisage
Environmental
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P.O. Box 152 Richfield, Ohio 44286
Phone (216) 526-0990

TEST RESULTS SUMMARY

The Hoover Company
101 East Maple Street
Canton, Ohio
Particulate & Sulfur Dioxide Emissions
Boiler # 3
Conducted - April 2, 1991

PARAMETER	RUN # 1	RUN # 2	RUN # 3
Particulate Emissions			
Pounds/Million BTU (Heat Input)	0.1916	0.1033	0.1588
Pounds/Million BTU (F Factor Coal)	0.2000	0.1199	0.1624
Pounds/hour	18.77	12.15	16.95
Grains/dscf	0.1008	0.0695	0.0940
Sulfur Dioxide Emissions			
Pounds/Million BTU (Heat Input)	3.80	3.31	3.81
Pounds/Million BTU (F Factor Coal)	3.97	3.84	3.89
Pounds/hour	372.40	389.41	406.51
Pounds/dscf	2.86E-04	3.18E-04	3.22E-04
ppmV	1718.3	1913.1	1937.3
System Flow Rates			
ACFM	54,253	53,392	54,416
DSCFM	21,727	20,405	21,036
Degrees Fahrenheit	699	709	695

.1512

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P.O. Box 152 Richfield, Ohio 44286
Phone (216) 526-0990

TEST RESULTS

DETAILED

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TEST RESULTS

The Hoover Company

Boiler # 3

Particulate & Sulfur Dioxide Emission Evaluation

DATE: April 2, 1991	Symbol	Units	RUN # 1	RUN # 2	RUN # 3
Time of Day			0907 1029	1053 1211	1249 1406
1 Gas Volume-dry,std.	Vmstd	cu. ft.	53.17	50.76	50.90
2 Condensate Vapor Vol.	Vwstd	cu. ft.	2.44	4.39	4.46
3 Gas Stream Moisture	Bws	vol.dec	0.0438	0.0796	0.0806
4 Mol.Wt-flue gas (dry)	Msd	lb/lb mo.	30.26	30.38	30.43
5 Mol.Wt-flue gas (wet)	Ms	lb/lb mo.	29.72	29.39	29.43
6 Flue Gas Velocity	Vs	ft/sec	60.28	59.32	60.46
7 Flue Gas Volume-Actual	ACFM	cu. ft.	54,253	53,392	54,416
8 Flue Gas Volume-Std.	DSCFM	cu. ft.	21,727	20,405	21,036
9 Particulate Conc.	Cs				
- Probe		gr/dscf	0.0326	0.0120	0.0257
- Filter		gr/dscf	0.0681	0.0575	0.0683
- Impingers		gr/dscf	N/A	N/A	N/A
- Total *		gr/dscf	0.1008	0.0695	0.0940
10 Emission Rate	E				
- Probe		lb/hr	6.08	2.09	4.64
- Filter		lb/hr	12.68	10.05	12.31
- Impingers		lb/hr	N/A	N/A	N/A
- Total *		lb/hr	18.77	12.15	16.95
11 Isokinetic Rate	I	%	95.7	97.3	94.6

* Totals DO NOT include impinger weights.

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OPERATIONAL PARAMETERS

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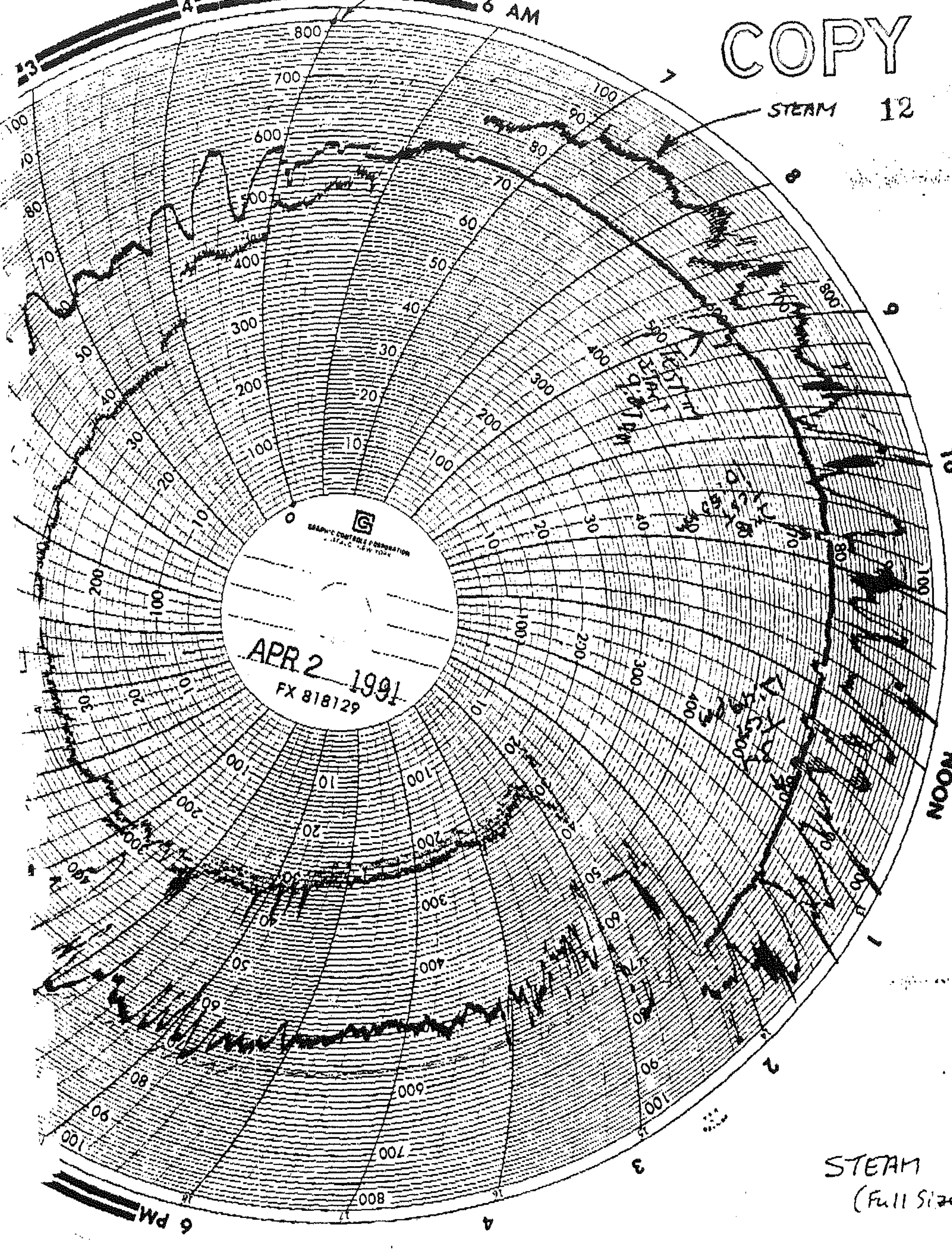
Incorporated
P.O. Box 152 Richfield, Ohio 44286
Phone (216) 526-0990

Bob Anderson

0 to 80,000 lb/hr.

COPY

STEAM 12



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Bob Ander

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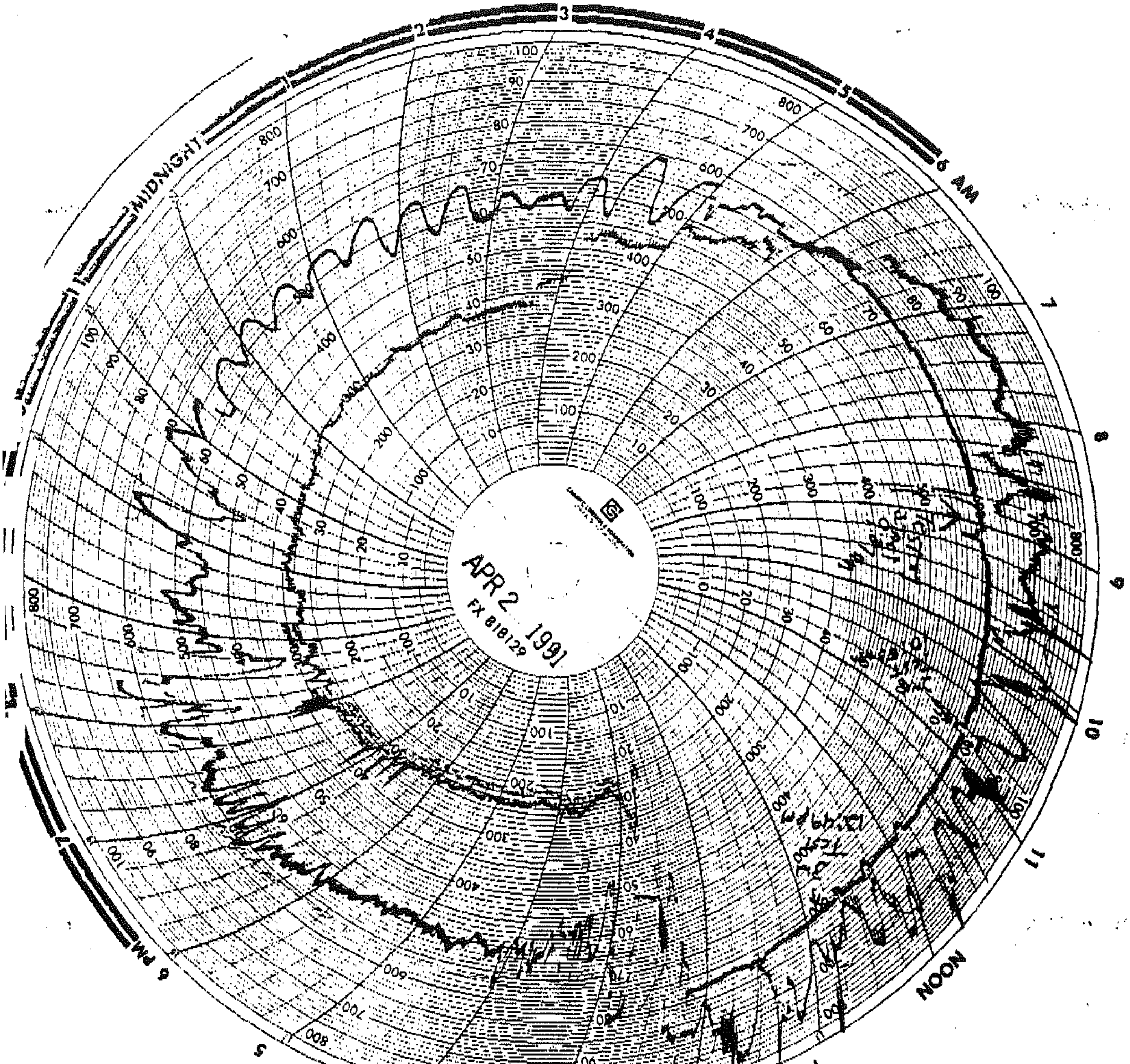

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Bob Anders

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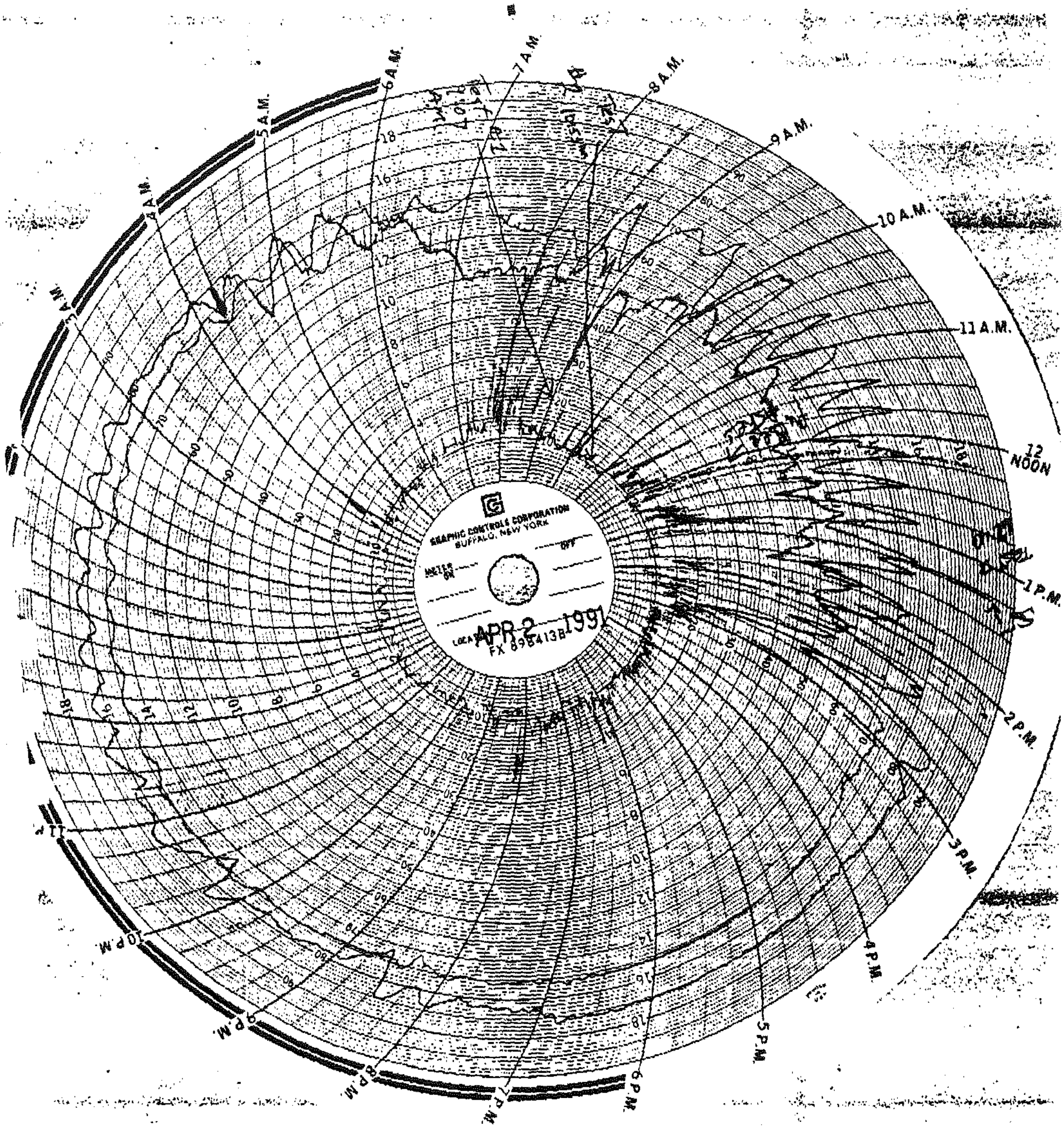

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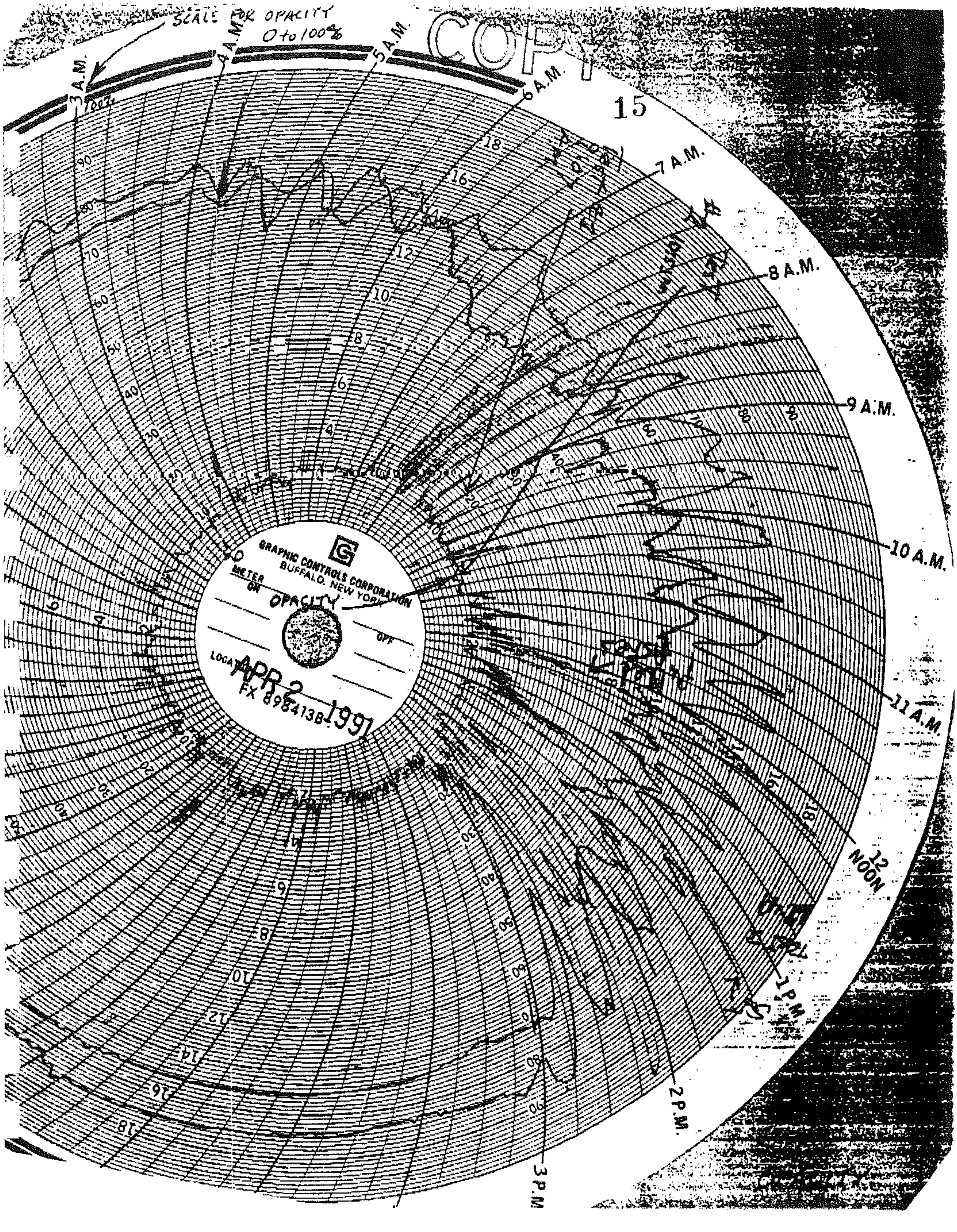
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GRAPHIC CONTROLS CORPORATION
BUFFALO, NEW YORK
METER
ON
OPACITY
OFF
LOCATION
APR 2 1991
FX 898413B

SCALE READINGS

NORTH SCALES — SOUTH SCALES

START – 9.07 AM FINISH – 10.19

TEST 1

	NORTH SCALES		SOUTH SCALES	
	699120	= 18	698858	= 18
	699138		698876	
	3600		3600	

7200 lbs
[illegible] JK
72 min

START – 1053 AM – FINISH – 12.09 PM

TEST 2

	NORTH SCALES		SOUTH SCALES	
	699147	= 23	698885	= 24
	699170		698909	
	4600		4800	

9400 lbs.
[illegible] JK
76 min

TEST 3 START – 12.49 PM – FINISH – 2.04 PM

	NORTH SCALES		SOUTH SCALES	
	699181	= 20	698920	= 21
	699201		698941	
	4000		4200	

8200 lbs.
[illegible] JK
75 min

FORM 1538

COAL ANALYSIS

Envisage
Environmental
Incorporated
P.O. Box 152 Richfield, Ohio 44286
Phone (216) 526-0990

COMMERCIAL TESTING & ENGINEERING CO.
GENERAL OFFICES: 1919 SOUTH HIGHLAND AVE., SUITE 210-B, LOMBARD, ILLINOIS 60148 • (312) 953-9300 18

SINCE 1908

Member of the SGS Group (Societe Generale de Surveillance)

April 9, 1991

PLEASE ADDRESS ALL CORRESPONDENCE TO:
2979 E. CENTER ST., CONNEAUT, OH 44030
TELEPHONE: (216) 224-2261
TELEX: 985-606 CT&E COUT
FAX: (216) 224-2808

ENVISAGE ENVIRONMENTAL
6940 Miller Road
Brecksville, OH 44141

Sample identification by
ENVISAGE ENVIRONMENTAL

IDENT: 91-1226
0304 297
Run #1

Kind of sample reported to us Coal

Sample taken at -----

Sample taken by Submitted

Date sampled -------

Date received April 4, 1991

APR 15

Analysis Report No. 87-23129

SHORT PROXIMATE - ULTIMATE ANALYSIS

	As Received	Dry Basis		
% Moisture	4.27	xxxxx		
% Carbon	75.29	78.65		
% Hydrogen	4.81	5.02		
% Nitrogen	1.54	1.61		
% Sulfur	2.40	2.51		
% Ash	4.84	5.06		
% Oxygen(diff)	6.85	7.15		
	100.00	100.00		
Btu/lb	13602	14209	MAF	14966

Respectfully submitted,
COMMERCIAL TESTING & ENGINEERING CO.

K. D. Meier

Manager, Conneaut Laboratory

COMMERCIAL TESTING & ENGINEERING CO.
GENERAL OFFICES: 1919 SOUTH HIGHLAND AVE., SUITE 210-B, LOMBARD, ILLINOIS 60148 • (312) 953-9300

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April 9, 1991

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2979 E. CENTER ST., CONNEAUT, OH 44030
TELEPHONE: (216) 224-2261
TELEX: 985-606 CT&E COUT
FAX: (216) 224-2808

ENVISAGE ENVIRONMENTAL
6940 Miller Road
Brecksville, OH 44141

Sample identification by
ENVISAGE ENVIRONMENTAL

IDENT: 91-1226
0304 297
Run #2

Kind of sample reported to us Coal

Sample taken at -----

Sample taken by Submitted

Date sampled ------

Date received April 4, 1991

APR 15

Analysis Report No. 87-23130

SHORT PROXIMATE - ULTIMATE ANALYSIS

	As Received	Dry Basis		
% Moisture	4.85	xxxxx		
% Carbon	73.11	76.84		
% Hydrogen	4.67	4.91		
% Nitrogen	1.43	1.50		
% Sulfur	2.67	2.81		
% Ash	6.68	7.02		
% Oxygen(diff)	6.59	6.92		
	100.00	100.00		
Btu/lb	13208	13881	MAF	14929

Respectfully submitted,
COMMERCIAL TESTING & ENGINEERING CO.

K.D. Meier

Manager, Conneaut Laboratory

COMMERCIAL TESTING & ENGINEERING CO.
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April 9, 1991

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TELEPHONE: (216) 224-2261
TELEX: 985-606 CT&E COUT
FAX: (216) 224-2808

ENVISAGE ENVIRONMENTAL
6940 Miller Road
Brecksville, OH 44141

Sample identification by
ENVISAGE ENVIRONMENTAL

IDENT: 91-1226
0304 297
Run #3

Kind of sample reported to us Coal

Sample taken at -----

Sample taken by Submitted

Date sampled ------

Date received April 4, 1991

APR 15 1991

Analysis Report No. 87-23131

SHORT PROXIMATE - ULTIMATE ANALYSIS

	As Received	Dry Basis		
% Moisture	4.47	xxxxx		
% Carbon	75.09	78.60		
% Hydrogen	4.65	4.87		
% Nitrogen	1.55	1.62		
% Sulfur	2.46	2.58		
% Ash	4.75	4.97		
% Oxygen(diff)	7.03	7.36		
	100.00	100.00		
Btu/lb	13557	14191	MAF	14933

Respectfully submitted,
COMMERCIAL TESTING & ENGINEERING CO.

K.D. Meier

Manager, Conneaut Laboratory

SAMPLE POINT LOCATION DIAGRAM

Envisage Environmental Incorporated
P.O. Box 152 Richfield, Ohio 44286
Phone (216) 526-0990

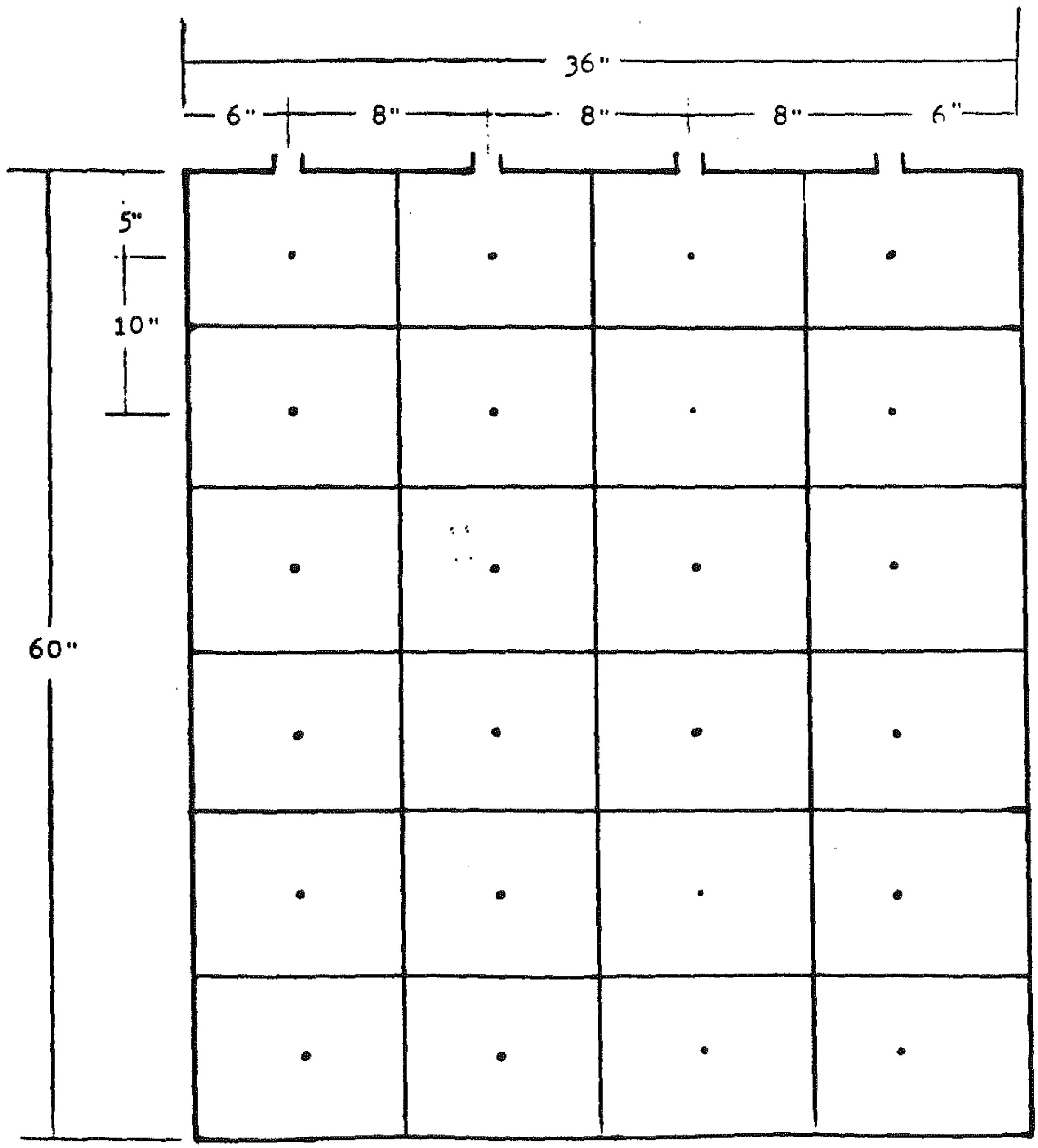
SAMPLE POINT LOCATIONS

The Hoover Company

North Canton, Ohio

Boiler Exhaust

Particulate Emission Testing



SAMPLE POINT DISTANCES

1) 55 inches
2) 45 inches
3) 35 inches
4) 25 inches
5) 15 inches
6) 5 inches

SAMPLING TRAIN DIAGRAM

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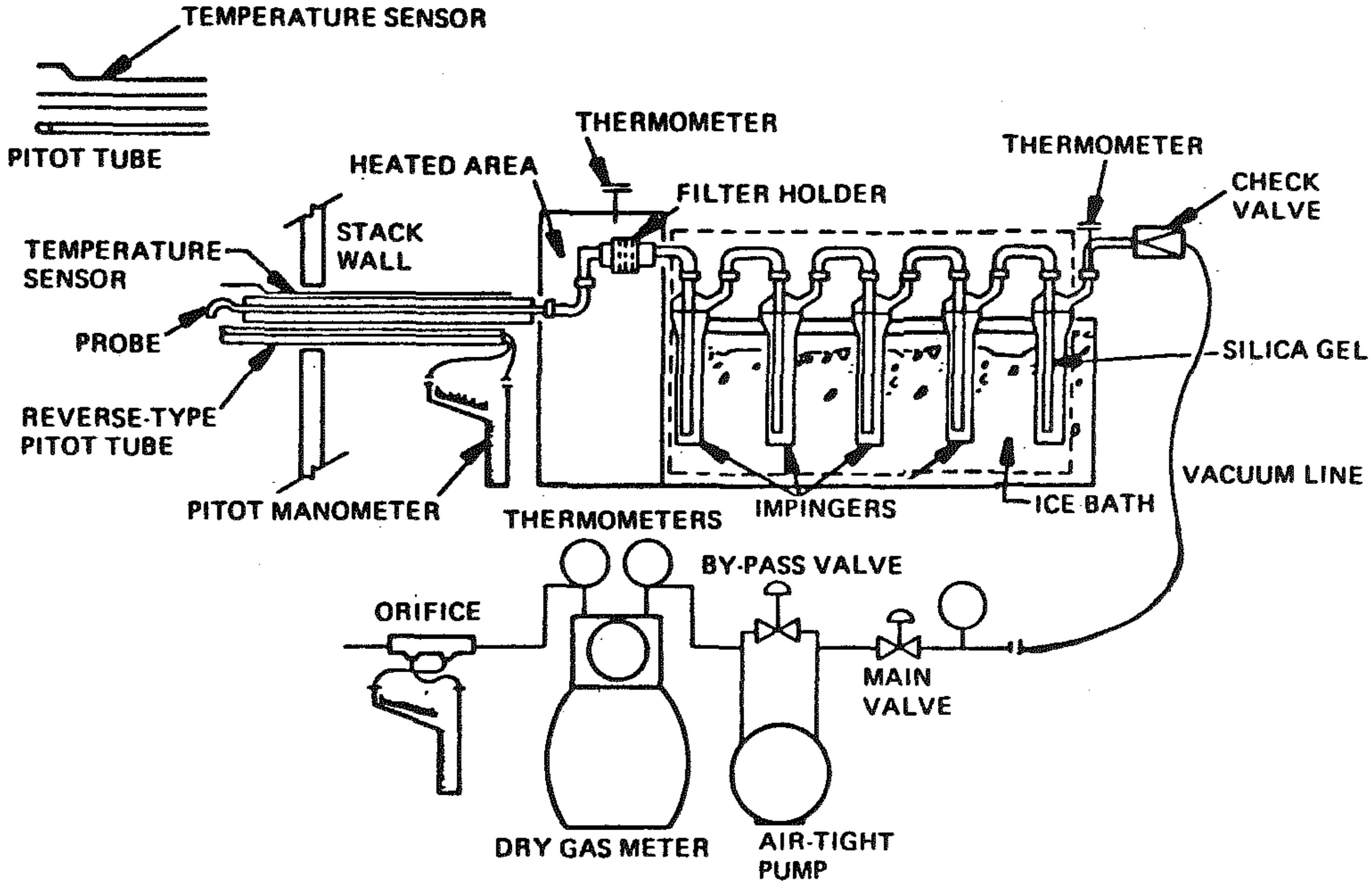
Phone (216) 526-0990



EPA Methods 1-6, Particulate and Sulfur Dioxide Sampling Train

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P.O. Box 152 Richfield, Ohio 44286
Phone (216) 526-0990

EMISSION SAMPLING

EQUIPMENT SPECIFICATIONS

Envisage
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P.O. Box 152 Richfield, Ohio 44286
Phone (216) 526-0990

Equipment and Specifications
U.S.E.P.A. Reference methods 1-5

Control Unit (Meter Box)	Equipment Designation
___ Envisage Environmental Inc.	Control Unit #'s MB- 08 & 09
✓ Anderson Samplers	Control Unit #'s MB- 01 - 02
___ Remanufactured R.A.C.	Control Unit #'s MB- 03 - 07

Sample Box	
✓ E.E.I.	SB- 01, 02 & 05 - 07
___ Remanufactured R.A.C.	SB- 03 & 04
___ E.E.I. Special Design	SB- 08 - 11

Impingers - per sample train (each set changed for each test run)	
✓ E.E.I.	3 Modified Smith Greenburg type
✓ E.E.I.	1 Smith Greenburg type

Probes	length	Lining types
___ E.E.I.	2 foot	SS, PYREX, QUARTZ
___ E.E.I.	3 foot	SS, PYREX, QUARTZ, TEFLON
___ E.E.I.	5 foot	SS, PYREX, QUARTZ, TEFLON
___ E.E.I.	3 foot	SS, PYREX, TEFLON
✓ E.E.I.	7 foot	SS, PYREX, TEFLON
___ E.E.I.	10 foot	SS, PYREX, TEFLON
___ E.E.I.	12 foot	SS, PYREX, TEFLON
___ E.E.I.	15 foot	SS, PYREX, TEFLON
___ E.E.I.	24 foot	SS, TEFLON

Temperature Sensors	Equipment Designation
___ Omega Engineering	PY- 01 & 02
___ Thermo Electric	PY- 03 - 08
✓ Fluke 51	PY- 01 - 02 - 03 - 04 - 05
___ Fisher Scientific	Mercury Thermometer
___ Fisher Scientific	Bimetallic Thermometer

Pressure Gauges	Type
✓ Dwyer Incline Manometer	Oil, 0 - 10 inch water
___ Dwyer Magnehelic	Magnetic/Mechanical 0 - 1 inch water
___ Dwyer Magnehelic	Magnetic/Mechanical 0 - 10 inch water
___ Dwyer "U" Tube Manometer	Mercury, 36 inches
___ Dwyer "U" Tube Manometer	Water, 72 inches
___ Dwyer Microtector (Micro - Manometer)	Water, 0 - 1 inches of water

Chemicals and Reagents	
✓ Water	Deionized/ Distilled
✓ Acetone	Reagent Grade (<0.001% residual)
✓ Silica Gel	6 - 16 Mesh
✓ Stopcock Grease	Acetone- Insoluble & Heat Resistant

Envisage Environmental Incorporated
P.O. Box 152 Richfield, Ohio 44286
Phone (216) 526-0990

LABORATORY SECTION

Envisage
Environmental
Incorporated
P.O. Box 152 Richfield, Ohio 44286
Phone (216) 526-0990

LABORATORY SUMMARY SHEET

The Hoover Company

Boiler # 3

Particulate & Sulfur Dioxide Emission Evaluation

DATE: April 2, 1991	Symbol	Units	RUN # 1	RUN # 2	RUN # 3
1 Sampling Time	t	minutes	72.0	72.0	72.0
2 Barometric Pressure	Pb	in. Hg	28.25	28.25	28.25
3 Static Pressure	Pg	in. H2O	-10.00	-10.00	-10.00
Stack Pressure	Ps	in. Hg	27.51	27.51	27.51
4 Gas Meter Volume	Vm	cu. ft.	63.04	60.66	60.30
5 Stack Area	A	sq. ft.	15.00	15.00	15.00
6 Nozzle Diameter	Dn	dec. in.	0.3125	0.3125	0.3125
7 Meter Temperature		degrees F	134.4	138.9	133.9
	Tm	degrees R	594.4	598.9	593.9
8 Stack Temperature		degrees F	699.3	709.3	694.8
	Ts	degrees R	1159.3	1169.3	1154.8
9 Velocity Head	^P	in. H2O	0.705	0.687	0.705
10 Orifice Pressure	^H	in. H2O	2.14	2.06	2.16
11 Carbon dioxide	CO2	%	12.5	13.8	14.1
12 Oxygen	O2	%	6.4	4.2	4.3
13 Carbon monoxide	CO	%	0.0	0.0	0.0
14 Nitrogen	N2	%	81.1	82.0	81.6
15 Pitot Coefficient	Cp		0.84	0.84	0.84
16 Water Collected	Vlc	ml	51.8	93.3	94.8
Sample Weight:	Mn				
17 - Probe		g	0.1125	0.0394	0.0849
18 - Filter		g	0.2347	0.1891	0.2252
19 - Impingers		g	N/A	N/A	N/A

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P.O. Box 152 Richfield, Ohio 44286
Phone (216) 526-0990

SO2 LABORATORY SUMMARY

The Hoover Company

Boiler # 3

Particulate & Sulfur Dioxide Emission Evaluation

DATE: April 2, 1991	Symbol	Units	RUN # 1	RUN # 2	RUN # 3
20 Normality of Ba(ClO4)2	N	meq/ml	0.0100	0.0100	0.0100
21 Volume of solution	Vsln	ml	270.0	280.0	282.0
22 Volume aliquot titrant	Va	ml	0.10	0.10	0.10
23 Volume Ba(ClO4)2 Blank	Vtb	ml	0.0	0.0	0.0
24 Volume Ba(ClO4)2 Sampl	Vt	ml	8.0	8.2	8.2

SO2 TEST RESULTS

The Hoover Company

Boiler # 3

Particulate & Sulfur Dioxide Emission Evaluation

DATE: April 2, 1991		Units	RUN # 1	RUN # 2	RUN # 3
12 Concentration SO2	Cso2	lb/dscf	2.86E-04	3.18E-04	3.22E-04
13 Concentration SO2	PPM	ppmV	1718.3	1913.1	1937.3
14 Emission Rate SO2	Eso2	lb/hr	372.40	389.41	406.51

Envisage Environmental Incorporated
P.O. Box 152 Richfield, Ohio 44286
Phone (216) 526-0990

AUDIT SAMPLE # 5579

Sulfur dioxide Concentration

$$C_{SO_2} = K_2 \frac{(V_t - V_{tb}) \; N \left[\frac{Vsln}{Va}\right]}{V_{m(given)}}$$

(EPA Equation 6-2)

Nomenclature:

C_{SO_2} = Concentration of sulfur dioxide in Audit sample, mg/dscm.

K_2 = Constant, 32.03 mg/meq.

V_t = Volume of barium perchlorate titrant used for the sample, ml (average of replicate titrations).

V_{tb} = Volume of barium perchlorate titrant used for the blank, ml.

N = Normality of barium perchlorate titrant, milliequivalents/ml.

V_{sln} = Volume of solution containing sulfur dioxide sample, ml.

V_a = Volume of aliquot titrated, ml.

$V_{m(given)}$ = Volume of gas sample (given with each audit sample), dscm.

Where:

V_t	=	1.73	ml	V_{sln}	=	100.0	ml
V_{tb}	=	0.00	ml	V_a	=	10.0	ml
N	=	0.0100	meq/ml	$V_{m(given)}$	=	0.0210	M^3

$$C_{SO_2} = 32.03 \frac{(\;1.73 \; - \; 0.00\;) \; 0.0100 \left[\frac{100.0}{10.0}\right]}{0.0210}$$

$$= \underline{263.9} \text{ mg/dscm}$$

$$\text{^\%} = \frac{\left[C_{SO_2} - C_{SO_2\,(given)}\right]}{C_{SO_2\,(given)}} \times 100$$

$$= \frac{263.9 - 260.0}{260.0} \times 100 = \underline{1.5} \;\%$$

Envisage Environmental Incorporated
P.O. Box 152 Richfield, Ohio 44286
Phone (216) 526-0990

PLANT Hoover Company

DATE April 2, 1991

RUN NO. 1

CASE NO. 13

CONTAINER NUMBER	WEIGHT OF PARTICULATE COLLECTED			
	FINAL WEIGHT	TARE WEIGHT	WEIGHT GAIN	
384	0.8618	0.6271	0.2347	FILTER
N/A	- -	- -	- -	IMPINGERS
12	104.3687	104.2562	0.1125	PROBE *

* Corrected for Acetone Blank

VOLUME OF LIQUID WATER COLLECTED			
	IMPINGER VOLUME (ml)	SILICA GEL WEIGHT (g)	
FINAL	330	253.0	
INITIAL	300	231.2	
NET LIQUID COLLECTED	30	21.8	
TOTAL NET VOLUME	51.8	g *	ml

* Convert weight of water to volume by dividing weight increase by density of water:

$$\frac{\text{Increase g}}{(1\ \text{g/ml})} = \text{Volume Water, ml}$$

Envisage Environmental Incorporated
P.O. Box 152 Richfield, Ohio 44286
Phone (216) 526-0990

PLANT Hoover Company

DATE April 2, 1991

RUN NO. 2

CASE NO. 20

CONTAINER NUMBER	WEIGHT OF PARTICULATE COLLECTED			
	FINAL WEIGHT	TARE WEIGHT	WEIGHT GAIN	
385	0.8120	0.6229	0.1891	FILTER
N/A	- -	- -	- -	IMPINGERS
182	106.0100	105.9706	0.0394	PROBE *

* Corrected for Acetone Blank

VOLUME OF LIQUID WATER COLLECTED			
	IMPINGER VOLUME (ml)	SILICA GEL WEIGHT (g)	
FINAL	375	249.5	
INITIAL	300	231.2	
NET LIQUID COLLECTED	75	18.3	
TOTAL NET VOLUME	93.3	g *	ml

* Convert weight of water to volume by dividing weight increase by density of water:

$$\frac{\text{Increase g}}{(1\ \text{g/ml})} = \text{Volume Water, ml}$$

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PLANT Hoover Company

DATE April 2, 1991

RUN NO. 3

CASE NO. 3

CONTAINER NUMBER	WEIGHT OF PARTICULATE COLLECTED			
	FINAL WEIGHT	TARE WEIGHT	WEIGHT GAIN	
367	0.8687	0.6435	0.2252	FILTER
N/A	- -	- -	- -	IMPINGERS
302	106.1924	106.1075	0.0849	PROBE *

* Corrected for Acetone Blank

VOLUME OF LIQUID WATER COLLECTED			
	IMPINGER VOLUME (ml)	SILICA GEL WEIGHT (g)	
FINAL	377	249.0	
INITIAL	300	231.2	
NET LIQUID COLLECTED	77	17.8	
TOTAL NET VOLUME	94.8	g *	ml

* Convert weight of water to volume by dividing weight increase by density of water:

$$\frac{\text{Increase g}}{(1\ \text{g/ml})} = \text{Volume Water, ml}$$

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CALIBRATION SECTION

Envisage
Environmental
Incorporated
P.O. Box 152 Richfield, Ohio 44286
Phone (216) 526-0990

METER BOX CALIBRATION

Meter Box Number: Andersen # 1

Calibration Date: March 4, 1991

$$Y = \frac{V_t \, P_b \, (T_m + 460)}{V_m \left[P_b + \frac{\hat{}H}{13.6} \right] (T + 460)}$$

$$\hat{}H_@ = \frac{0.0317 \; \hat{}H}{P_b \; (Tm + 460)} \left[\frac{(T_t + 460) \; t}{V_t} \right]$$

Delta H (^H)	in. H2O	0.5	1.0	3.0	5.0	7.0
Pres.Barometer (P_b)	in. Hg	29.85	29.85	29.85	29.85	29.85
Vol.Meter Box (V_m)	cu. ft.	4.270	6.095	10.500	13.426	15.850
Vol.Test Meter(V_t)	cu. ft.	4.070	5.753	9.941	12.753	15.058
Temp. Meter Box (T_m)	$^o F$	95.2	98.7	101.7	105.2	108.4
	$^o R$	555.2	558.7	561.7	565.2	568.4
Temp. Test Meter (T_t)	$^o F$	69.0	69.0	69.0	69.0	69.0
	$^o R$	529.0	529.0	529.0	529.0	529.0
Time (t)	minutes	10.0	10.0	10.0	10.0	10.0
METER FACTOR (Y)		0.999	0.994	0.998	1.003	1.003
- Average				1.00		
METER COEFFICIENT ($\hat{}H_@$)		1.616	1.607	1.606	1.616	1.614
- Average				1.61		

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"S" TYPE PITOT TUBE CALIBRATION

"S" Type Pitot Tube (Probe) # 70 - 7 ft Probe

Calibration Date: March 4, 1991

$$C_p = C_{std} \sqrt{\frac{\Delta P_{std}}{\Delta P_p}} \qquad \text{(EPA Equation 2-2)}$$

where:

C_p = Coefficient of Type S pitot tube, dimensionless

C_{std} = Coefficient of Standard Pitot Tube (0.99), dimensionless

ΔP_{std} = Velocity head measured by standard pitot tube, inches H_2O

ΔP_p = Velocity head measured by Type S pitot tube, inches H_2O

	ΔP_{std}	ΔP_p	C_p
Side A	0.21	0.29	0.842
Side B	0.21	0.29	0.842
Side A	0.34	0.47	0.842
Side B	0.34	0.47	0.842
Side A	0.58	0.80	0.843
Side B	0.58	0.80	0.843

Average - 0.84

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NOZZLE DIAMETER CALIBRATION

I.D. of nozzles are checked periodically by inside micrometer on at least 12 different diameters. If deviation exceeds +0.001" on an average or 0.002" maximum, nozzle is reworked. Sharpening occurs after each test.

CALIBRATION FREQUENCY

The frequency of calibration is dictated by the Federal Register, Volume 42, Number 160, August 18, 1977. The regulations state that you must "use methods and equipment which have been approved by the Administrator to calibrate the orifice meter, pitot tube, dry gas meter, and probe heater. Recalibrate after each test".

The methods of calibration are determined from "Maintenance, Calibration, and Operation of Isokinetic Source Sampling Equipment," published by the U.S. EPA Office of Air Program Publications APTD-0576. Per the above listed regulations, the equipment was checked after the stack test and the values of Y, Cp (Test) and nozzle diameter had not appreciably changed from the acceptable tolerances.

Envisage Environmental Incorporated
P.O. Box 152 Richfield, Ohio 44286
Phone (216) 526-0990

FIELD DATA SHEETS

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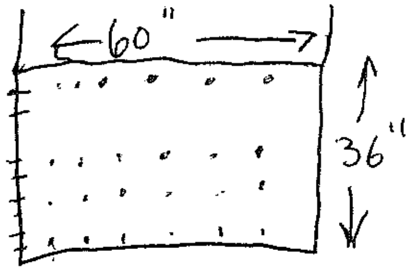
Phone (216) 526-0990

FIELD DATA

PLANT Hoover
DATE 4-2-91
SAMPLING LOCATION Boiler #3 exhaust
SAMPLE TYPE 6
OPERATOR MG, JK, GS
AMBIENT TEMPERATURE 100'S
BAROMETRIC PRESSURE 28.25
STATIC PRESSURE -10.0
HEATER BOX SETTING 320



SCHEMATIC OF TRAVERSE POINT LAYOUT

PROBE LENGTH & TYPE 7'
NOZZLE I.D. .3125
ASSUMED MOISTURE % 6
METER BOX NUMBER 1
METER ΔH @ 1.61
C FACTOR .95
PITOT CORRECTION FACTOR .84
PRE-TEST LEAK CHECK 0 CFM@ 15 "Hg
POST-TEST LEAK CHECK 0 CFM@ 15 "Hg
Pre-Test Pitot 0@6.2 0@5.7
Post-Test Pitot 0@5.9 0@5.4

Run #1
Case #13

READ AND RECORD ALL DATA EVERY 3 MINUTES

PAGE 1 OF 3

Rf. 42 = 700

TRAVERSE POINT NUMBER	ELAPSED SAMPLING TIME min.	GAS METER READING	VELOCITY HEAD		ORIFICE PRESSURE DIFFERENTIAL	STACK TEMPERATURE	GAS METER TEMPERATURE INLET	GAS METER TEMPERATURE OUTLET	PUMP VACUUM	FILTER HOLDER TEMP.	IMPINGER TEMP.
1	0 9:07	205.30	.41	.640	1.8	607	120	116	5.0	310	46
2	3	207.7	.41	.640	1.8	609	126	113	5.0	317	48
3	6	209.92	.35	.592	1.5	684	129	114	5.0	320	48
4	9	212.2	.46	.632	1.75	705	135	115	5.0	320	49
5	12	214.6	.55	.742	2.3	710	140	117	5.0	320	51
6	15	217.25	.65	.806	2.8	714	143	118	6.0	317	51
1	18	220.2	.55	.742	2.3	713	144	123	5.0	318	52
2	21	222.9	.52	.721	2.25	711	146	122	5.0	313	52
3	24	225.45	.48	.693	2.0	701	147	124	5.0	312	54
4	27	227.95	.50	.707	2.2	704	149	125	6.0	310	54
5	30	230.23	.50	.707	2.2	715	149	123	5.0	315	55
6	33	232.77	.40	.632	1.75	711	149	126	10.0	319	56
1	36	235.20	.54	.735	2.3	719	143	126	10.0	316	56
2	39	237.73	.54	.735	2.3	715	147	126	11.0	317	56
3	42	240.55	.54	.735	2.3	714	148	128	13.0	320	57
4	45	242.63	.55	.742	2.35	710	149	126	12.0	320	59
5	48	246.95	.45	.671	1.9	696	150	128	12.0	317	59
6	51	250.1	.60	.775	2.5	673	150	126	12.0	319	59
1	54	253.91	.45	.671	1.9	711	149	127	12.0	314	60
2	57	255.72	.50	.707	2.2	716	150	128	11.0	313	60
3	60	258.6	.55	.742	2.3	719	153	129	12.0	316	61
4	63	261.4	.55	.742	2.3	716	156	129	12.0	317	61
5	66	264.10	.50	.707	2.2	702	155	129	12.0	318	62
6	69	266.46	.50	.707	2.2	698	158	129	12.0	319	64
	72 10:29	268.34									
		63.04		.705	2.14	699.3	134.4				

PLANT Hoover DATE 4-2-91 LEAK CHECK Pre 0 CFM@ 15 "Hg PAGE 2 OF 3

RUN #2 Case #20 Post 0 12.0

TRAVERSE POINT NUMBER	ELAPSED SAMPLING TIME min.	GAS METER READING	VELOCITY HEAD		ORIFICE PRESSURE DIFFERENTIAL	STACK TEMPERATURE	GAS METER TEMPERATURE INLET	GAS METER TEMPERATURE OUTLET	PUMP VACUUM	FILTER HOLDER TEMP.	IMPINGER TEMP.
1	0 // 10:53	268.50	.33	.574	1.5	708	132	124	6.0	317	48
2	3	270.74	.40	.632	1.75	705	136	126	7.0	319	48
3	6	273.1	.40	.632	1.75	694	145	128	7.0	320	49
4	9	275.37	.45	.671	1.9	711	148	128	7.0	316	49
5	12	277.9	.50	.707	2.2	703	150	128	7.0	315	51
6	15	280.6	.50	.707	2.2	707	154	128	7.0	318	51
1	18	283.07	.50	.707	2.2	719	147	127	8.0	319	51
2	21	285.65	.57	.755	2.45	718	150	128	8.0	320	52
3	24	288.4	.55	.742	2.3	717	151	130	8.0	317	52
4	27	291.1	.57	.755	2.45	714	155	128	8.0	315	54
5	30	293.85	.48	.693	2.1	710	157	131	9.0	319	55
6	33	296.45	.45	.671	1.9	706	155	129	9.0	320	57
1	36	299.10	.42	.648	1.86	717	147	129	8.0	315	58
2	39	301.3	.40	.632	1.75	715	149	128	8.0	317	59
3	42	303.65	.50	.707	2.2	714	152	130	9.0	315	59
4	45	306.33	.50	.707	2.2	713	153	128	10.0	318	61
5	48	308.90	.45	.671	1.9	710	154	129	10.0	319	61
6	51	311.29	.42	.648	1.85	707	154	129	9.0	316	61
1	54	313.7	.50	.707	2.2	712	145	128	10.0	319	67
2	57	316.26	.55	.747	2.3	710	148	128	10.0	320	62
3	60	318.9	.50	.707	2.2	707	151	130	10.0	319	63
4	63	321.5	.45	.671	1.9	705	149	128	10.0	320	64
5	66	323.97	.50	.707	2.2	701	157	128	10.0	314	64
6	69	326.60	.48	.693	2.1	701	152	130	9.5	320	65
	72 // 12:11	329.155									
		60.655		.687	2.06	709.33	138.85				

Pre
0@5.9 #2
0@6.2 #4

Post
0@5.7
0@6.1

PLANT Hoover Company DATE 4-2-91 LEAK CHECK pre 0 post 0 CFM@ 15 / 10 "Hg PAGE 3 OF 3

Run #3 Case #3

soot blown 1:29 pm 34 sec.

TRAVERSE POINT NUMBER	ELAPSED SAMPLING TIME min.	GAS METER READING	VELOCITY HEAD		ORIFICE PRESSURE DIFFERENTIAL	STACK TEMPERATURE	GAS METER TEMPERATURE INLET	GAS METER TEMPERATURE OUTLET	PUMP VACUUM	FILTER HOLDER TEMP.	IMPINGER TEMP.
1	0// 12:49	335.00	.30	.548	1.30	669	115	123	3.0	280	66
2	3	338.15	.30	.548	1.30	679	116	135	4.0	315	64
3	6	340.3	.50	.707	2.2	692	141	119	4.0	311	64
4	9	343.25	.50	.707	2.2	692	142	121	4.0	314	60
5	12	345.41	.45	.671	1.9	682	142	120	4.0	317	60
6	15	347.9	.45	.671	1.9	675	143	120	4.0	320	60
1	18	350.31	.48	.693	2.1	691	137	121	4.0	316	56
2	21	352.85	.50	.707	2.2	689	142	120	4.0	319	56
3	24	355.46	.55	.742	2.3	695	145	122	5.0	316	56
4	27	358.14	.55	.742	2.3	696	146	124	5.0	312	56
5	30	360.76	.57	.755	2.45	697	147	123	5.0	314	55
6	33	363.65	.65	.806	2.8	702	147	124	5.0	312	55
1	36	366.37	.57	.755	2.45	707	140	123	5.0	312	56
2	39	369.15	.65	.806	2.8	705	145	126	5.0	314	57
3	42	371.96	.45	.671	1.9	701	147	127	5.0	316	57
4	45	374.4	.48	.693	2.1	697	149	126	5.0	319	57
5	48	376.94	.45	.671	1.9	693	147	125	5.0	320	58
6	51	379.4	.40	.632	1.75	690	149	126	5.0	320	58
1	54	381.76	.65	.806	2.8	703	146	128	5.0	312	59
2	57	384.73	.65	.806	2.8	705	148	128	5.0	314	59
3	60	387.52	.55	.742	2.3	706	149	128	5.5	316	59
4	63	390.23	.50	.707	2.2	706	150	129	6.0	314	58
5	66	392.83	.48	.693	2.1	704	149	128	6.0	312	61
6	69	395.3	.40	.632	1.75	700	150	129	6.0	310	61
	72// 2:06										
		60.30		.705	2.16	694.8		133.9			

pitot tube pre 0 @ 6.7 post 0 @ 6.1
lk. chk pre 0 @ 6.7 post 0 @ 5.7

EMISSIONS SAMPLING NOMENCLATURE

Envisage
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Phone (216) 526-0990

PARTICULATE SAMPLING NOMENCLATURE

A	=	Cross sectional area of stack or duct, ft^2.
A_n	=	Cross sectional area of nozzle, ft^2.
B_{ws}	=	Water vapor in gas stream, proportion by volume.
C	=	Nomograph correction factor, dimensionless.
C_p	=	Pitot tube coefficient, dimensionless.
C_s	=	Concentration of particulate matter in gas stream, dry basis-corrected to standard conditions, gr/dscf.
D_n	=	Nominal diameter of probe nozzle tip, inches.
E	=	Particulate Emission Rate, lb/hr.
^H	=	Average pressure differential across orifice, in. H_2O.
^$H_@$	=	Orifice meter calibration factor, in. H_2O.
I	=	Percent of Isokinetic sampling, %.
K_p	=	Pitot tube constant, $85.49 \frac{ft}{sec} \left[\frac{(lb/lb\text{-}mole)(in.Hg)}{(^{o}R)(in.H_2O)}\right]$
M_d	=	Molecular weight of gas, dry basis, lb/lb-mole.
M_n	=	Total amount of particulate matter collected, g.
M_s	=	Molecular weight of gas, wet basis, lb/lb-mole.

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Particulate Sampling Nomenclature - continued

M_w = Molecular weight of water, 18 lb/lb-mole.

P_{bar} = Barometric Pressure, in. Hg.

P_g = Pressure differential from gas stream to atmosphere, (static pressure) in.H_2O.

P_s = Absolute gas stream pressure, (P_{bar} + P_g/13.6) in.Hg.

P_{std} = Absolute pressure at standard conditions, 29.92 in. Hg.

P_w = Density of water, 0.0022 lb/ml.

$\wedge P_{avg}$ = Average of the square roots of the velocity head readings, ($\sqrt{\wedge p}$) (in.H O_2).

Q = Volumetric flow rate at gas stream conditions, A.C.F.M.

Q_{sd} = Dry volumetric gas flow rate corrected to standard conditions, S.C.F.M.

R = Ideal gas constant, 21.85 in. Hg-ft^3/ ^oR-lb-mole.

t = Total sampling time, minutes.

T_m = Average dry gas meter temperature, ^oR.

T_s = Average absolute gas stream temperature, ^oR.

T_{std} = Standard absolute temperature, 528^o Rankine.

V_{lc} = Volume of water collected in impingers & silica gel, ml.

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Particulate Sampling Nomenclature - continued

V_m = Volume of gas sample measured at meter box (meter conditions), ft^3

$V_{m(std)}$ = Volume of gas sample measured at meter box (corrected to standard conditions), ft^3.

V_s = Average gas stream velocity, ft/sec.

$V_{w(std)}$ = Volume of water vapor in gas sample (standard conditions) ft^3.

13.6 = Specific gravity of mercury (Hg).

% CO_2 = Percent by volume of CO_2 in gas stream (dry basis).

% O_2 = Percent by volume of O_2 in gas stream (dry basis).

% CO = Percent by volume of CO in gas stream (dry basis).

% N_2 = Percent by volume of N_2 in gas stream (dry basis).

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EMISSION SAMPLING

CALCULATIONS

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P.O. Box 152 Richfield, Ohio 44286
Phone (216) 526-0990

1) Volume of dry gas sampled through meter box at standard conditions,

$$V_{m(std)} = V_m \left[\frac{T_{std}}{T_m} \right] \left[\frac{P_b + \frac{\Delta H}{13.6}}{P_{std}} \right]$$

(EPA Equation 5-1)

Where:

$V_{m(std)}$ = Volume of gas sample measured at meter box (corrected to standard conditions), ft^3.

V_m = Volume of gas sample measured at meter box (meter conditions), ft^3.

T_{std} = Standard absolute temperature, 528^o Rankine.

T_m = Average dry gas meter temperature, ^oR.

P_{bar} = Barometric Pressure, in. Hg.

^H = Average pressure differential across orifice, in. H_2O.

13.6 = Specific gravity of mercury (Hg).

P_{std} = Absolute pressure at standard conditions, 29.92 in. Hg.

Example: Run 1

V_m = 63.04 ft^3

T_m = 594.4 ^oR

^H = 2.14 in. H_2O

P_{bar} = 28.25 in. Hg

$$V_{m(std)} = 63.04 \left[\frac{528.0}{594.4} \right] \left[\frac{28.25 + \frac{2.14}{13.6}}{29.92} \right]$$

$$= \underline{53.17} \; ft^3$$

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2) Volume of water vapor collected at standard conditions,

$$V_{w(std)} = V_{lc} \left[\frac{P_w}{M_w} \right] \left[\frac{(R)(T_{std})}{P_{std}} \right]$$

(EPA Equation 5-2)

Where:

$V_{w(std)}$ = Volume of water vapor in gas sample (standard conditions) ft^3.

V_{lc} = Volume of water collected in impingers & silica gel, ml.

P_w = Density of water, 0.0022 lb/ml.

M_w = Molecular weight of water, 18 lb/lb-mole.

R = Ideal gas constant, 21.85 in. Hg-ft^3/ ^oR-lb-mole.

T_{std} = Standard absolute temperature, 528 ^{o} Rankine.

P_{std} = Absolute pressure at standard conditions, 29.92 in. Hg.

Example: Run 1

V_{lc} = 51.8 ml

$$V_{w(std)} = 51.8 \left[\frac{0.0022}{18.0} \right] \left[\frac{(21.85)\quad(528.0)}{29.92} \right]$$

$$= \underline{2.44}\ ft^3$$

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3) Moisture content of gas stream,

$$B_{ws} = \frac{V_{w(std)}}{V_{m(std)} + V_{w(std)}}$$

(EPA Equation 5-3)

Where:

B_{ws} = Water vapor in gas stream, proportion by volume.

$V_{w(std)}$ = Volume of water vapor in gas sample (standard conditions) ft^3.

$V_{m(std)}$ = Volume of gas sample measured at meter box (corrected to standard conditions), ft^3.

Example: Run 1

$V_{w(std)}$ = 2.44 ft^3

$V_{m(std)}$ = 53.17 ft^3

$$B_{ws} = \frac{2.44}{53.17 + 2.44}$$

$$= 0.0439$$

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4) Dry Molecular Weight of gas in gas stream,

$$M_d = 0.440\ (\%CO_2) + 0.320\ (\%O_2) + 0.280\ (\%N_2 + \%CO)$$

(EPA Equation 3-2)

Where:

M_d = Molecular weight of gas, dry basis, lb/lb-mole.

0.440 = Molecular weight of CO_2 divided by 100.

0.320 = Molecular weight of O_2 divided by 100.

0.280 = Molecular weight of N_2 or CO (same for both compounds) divided by 100.

$\% CO_2$ = Percent by volume of CO_2 in gas stream (dry basis).

$\% O_2$ = Percent by volume of O_2 in gas stream (dry basis).

% CO = Percent by volume of CO in gas stream (dry basis).

$\% N_2$ = Percent by volume of N_2 in gas stream (dry basis).

Example: Run 1

$\% CO_2$ = 12.5

$\% O_2$ = 6.4

% CO = 0.0

$\% N_2$ = 81.1

$$M_d = 0.440\ (12.5) + 0.320\ (6.4) + 0.280\ (81.1)$$

$$= 30.26 \text{ lb/lb-mole}$$

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5) Molecular Weight of gas in gas stream,

$$M_s = M_d \, (1 - B_{ws}) + M_w \, (B_{ws})$$

(EPA Equation 2-5)

Where:

M_s = Molecular weight of gas, wet basis, lb/lb-mole.
M_d = Molecular weight of gas, dry basis, lb/lb-mole.
B_{ws} = Water vapor in gas stream, proportion by volume.
M_w = Molecular weight of water, 18 lb/lb-mole.

Example: Run 1

M_d = 30.26 lb/lb-mole

B_{ws} = 0.0439

$$M_s = 30.26 \, (1 - 0.0439) + 18 \, (0.0439)$$

$$= \underline{29.72} \text{ lb/lb-mole}$$

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6) Average Gas Stream Velocity,

$$V_s = K_p \; C_p \; \hat{}P_{avg} \sqrt{\frac{T_s}{P_s \; M_s}}$$

(EPA Equation 2-9)

Where:

V_s = Average gas stream velocity, ft/sec.

K_p = Pitot tube constant, 85.49 $\frac{ft}{sec} \left[\frac{(lb/lb\text{-}mole)(in.Hg)}{(^oR)(in.H_2O)}\right]^{1/2}$

C_p = Pitot tube coefficient, dimensionless.

$\hat{}P_{avg}$ = Average of the square roots of the velocity head readings, ($\sqrt{\hat{}p}$) ($in.H_2O$).

T_s = Average absolute gas stream temperature, ^oR.

P_s = Absolute gas stream pressure,(P_{bar} + P_g/13.6) in.Hg.

P_{bar} = Barometric Pressure, in. Hg.

P_g = Pressure differential from gas stream to atmosphere, (static pressure) $in.H_2O$.

M_s = Molecular weight of gas, wet basis, lb/lb-mole.

Example: Run 1

C_p = 0.84

$\hat{}P_{avg}$ = 0.705 $in.H_2O^{1/2}$

T_s = 1159.3 ^oR

P_s = P_{bar} + P_g /13.6 = 28.25 + -10.00 /13.6 = 27.51 in.Hg

M_s = 29.72 lb/lb-mole

$$V_s = (\ 85.49\ )(\ 0.84\ )\ (\ 0.705\ ) \sqrt{\frac{1159.3}{(\ 27.51\ )\ (\ 29.72\ )}}$$

= 60.28 ft/sec

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7) Volumetric Flow Rate at Gas Stream Conditions,

$$Q = A \times V_s \times 60$$

Where:

Q = Volumetric flow rate at gas stream conditions, A.C.F.M.

A = Cross sectional area of stack or duct, ft^2.

V_s = Average gas stream velocity, ft/sec.

60 = Conversion factor from seconds to minutes.

Example: Run 1

A = 15.00 ft^2

V_s = 60.28 ft/sec

$$Q = (15.00)(60.28)\ 60$$

$$= \underline{54,254}\ \text{ACFM}$$

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8) Volumetric Flow Rate at Standard Conditions,

$$Q_{sd} = 60 \; (1 - B_{ws}) \; V_s \; A \left[\frac{T_{std}}{T_s}\right] \left[\frac{P_s}{P_{std}}\right]$$

(EPA Equation 2-10)

Where:

Q_{sd} = Dry volumetric gas flow rate corrected to standard conditions, S.C.F.M.

60 = Conversion factor from seconds to minutes.

B_{ws} = Water vapor in gas stream, proportion by volume.

V_s = Average gas stream velocity, ft/sec.

A = Cross sectional area of stack or duct, ft^2.

T_{std} = Standard absolute temperature, 528 ^{o} Rankine.

T_s = Average absolute gas stream temperature, ^oR.

P_s = Absolute gas stream pressure,(P_{bar} + P_g/13.6) in.Hg.

P_{bar} = Barometric Pressure, in. Hg.

P_g = Pressure differential from gas stream to atmosphere, (static pressure) in.H_2O.

P_{std} = Absolute pressure at standard conditions, 29.92 in. Hg.

Example: Run 1

B_{ws} = 0.0439

V_s = 60.28 ft/sec

A = 15.00 ft^2

T_s = 1159.3 ^oR

P_s = $P_{bar} + P_g$ /13.6 = 28.25 + -10.00 /13.6 = 27.51 in.Hg

$$Q_{sd} = 60 \; (1 - 0.0439) \; (60.28) \; (15.00) \left(\frac{528.0}{1159.3}\right)\left(\frac{27.51}{29.92}\right)$$

= 21,726 SCFM

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9) Gas Stream Particulate Concentration,

$$C_s = 15.43 \text{ gr./g} \left[\frac{M_n}{V_{m(std)}} \right]$$

(EPA Equation 5-6)

Where:

C_s = Concentration of particulate matter in gas stream, dry basis-corrected to standard conditions, gr/dscf.

M_n = Total amount of particulate matter collected in probe wash and on filter, g.

$V_{m(std)}$ = Volume of gas sample measured at meter box (corrected to standard conditions), ft^3.

Example: Run 1

$$M_n = \underset{(\text{ probe })}{0.1125} + \underset{(\text{ filter })}{0.2347} = 0.3472 \text{ g}$$

$$V_{m(std)} = 53.17 \text{ ft}^3$$

$$C_s = 15.43 \left[\frac{0.3472}{53.17} \right]$$

$$= \underline{0.1008} \text{ gr/dscf}$$

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10) Particulate Emission Rate,

$$E = Q_{sd} \quad C_s \left[\frac{1 \text{ pound}}{7000 \text{ grains}} \right] \left[\frac{60 \text{ minutes}}{1 \text{ hour}} \right]$$

Where:

E = Particulate Emission Rate, lb/hr.

Q_{sd} = Dry volumetric gas flow rate corrected to standard conditions, S.C.F.M.

C_s = Concentration of particulate matter in gas stream, dry basis-corrected to standard conditions, gr/dscf.

Example: Run 1

Q_{sd} = 21,726 ft^3

C_s = 0.1008 gr/dscf

$$E = (21{,}726)\ (0.1008) \left[\frac{60}{7000} \right]$$

$$= \underline{18.76} \text{ lb/hr}$$

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11) Percent of Isokinetic Sampling,

$$I = \frac{100\ T_s \left[K_3\ V_{1c} + \left[\frac{V_m}{T_m}\right] \left[P_{bar} + \frac{\hat{}H}{13.6} \right] \right]}{60\ A_n\ V_s\ P_s\ t}$$

(EPA Equation 5-7)

Where:

I = Percent of Isokinetic sampling, %.

T_s = Average absolute gas stream temperature, ^oR.

K_3 = Constant, 0.002669 in.Hg-ft^3/ml-^oR.

V_{1c} = Volume of water collected in impingers & silica gel, ml.

V_m = Gas sample volume measured at meter box (meter conditions), ft^3.

T_m = Average dry gas meter temperature, ^oR.

P_{bar} = Barometric Pressure, in. Hg.

^H = Average pressure differential across orifice, in. H_2O.

t = Total sampling time, minutes.

V_s = Average gas stream velocity, ft/sec.

P_s = Absolute gas stream pressure, in.Hg.

D_n = Nominal diameter of probe nozzle tip, inches.

A_n = Cross sectional area of nozzle, ft^2.

Example: Run 1

T_s	=	1159.3	^oR	^H	=	2.14	in.H_2O
V_{1c}	=	51.8	ml	t	=	72.0	min.
V_m	=	63.04	ft^3	V_s	=	60.28	ft/sec
T_m	=	594.4	^oR	P_s	=	27.51	in.Hg
A_n	=	0.0005326	ft^2	P_{bar}	=	28.25	in.Hg

$$I = \frac{1159.3\ (100) \left[0.002669\ (51.8) + \left[\frac{63.04}{594.4}\right] \left[28.25 + \frac{2.14}{13.6} \right] \right]}{60\ (0.0005326)\ (60.28)\ (27.51)\ (72.0)}$$

= 95.7 %

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12) Ratio of the Volume of Flue Gas Generated to the Fuel Consumed,

$$F_d = \frac{10^6 \left[3.64(\%H) + 1.53(\%C) + 0.57(\%S) + 0.14(\%N) - 0.46(\%O) \right]}{G\ C\ V}$$

Where:

F_d = Factor representing a ratio of the volume of dry flue gases generated to the calorific value of the fuel combusted, dscf/million BTU.

% H = Content by weight of Hydrogen in fuel (as determined by Ultimate fuel analysis) (dry basis), %.

% C = Content by weight of Carbon in fuel (as determined by Ultimate fuel analysis) (dry basis), %.

% S = Content by weight of Sulfur in fuel (as determined by Ultimate fuel analysis) (dry basis), %.

% N = Content by weight of Nitrogen in fuel (as determined by Ultimate fuel analysis) (dry basis), %.

% O = Content by weight of Oxygen in fuel (as determined by Ultimate fuel analysis) (dry basis), %.

GVC = Gross Calorific Value of the fuel (as determined by Proximate fuel analysis) (dry basis), BTU.

Example: Run 1

% H	=	5.02	% by weight
% C	=	78.65	% by weight
% S	=	2.51	% by weight
% N	=	1.61	% by weight
% O	=	7.15	% by weight
GVC	=	14,209	BTU/lb

$$F_d = \frac{10^6 \left[3.64(5.02) + 1.53(78.65) + 0.57(2.51) + 0.14(1.61) - 0.46(7.15) \right]}{14,209}$$

= 9,640 dscf/million BTU

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13) Particulate Emission Rate per Unit of Fuel Input,

$$E_f = C_d \quad F_d \left[\frac{20.9}{20.9 - \%\, O_2} \right]$$

Where:

E_f = Emission Rate of Particulates per unit of fuel input, dry basis, (Oxygen based F Factor), pounds/million BTU.

C_d = Concentration of particulate matter in gas stream, dry basis, corrected to standard conditions, pounds/dscf.

C_s = Concentration of particulate matter in gas stream, dry basis, corrected to standard conditions, grains/dscf.

F_d = Factor representing a ratio of the volume of dry flue gases generated to the calorific value of the fuel combusted, dscf/million BTU.

$\%\, O_2$ = Percent by volume of O_2 in gas stream (dry basis).

Example: Run 1

C_s = 0.1008 gr/dscf

$$C_d = C_s \times \frac{1 \text{ pound}}{7000 \text{ grains}} = \frac{0.1008}{7000} = 1.4394 \times 10^{-5} \text{ lb/dscf}$$

F_d = 9640.0 dscf/million BTU

$\%\, O_2$ = 6.4 %

$$E_f = \left(\frac{0.1008}{7000} \right) \quad (9640.0) \left[\frac{20.9}{20.9 - 6.4} \right]$$

$$= \underline{0.2000} \text{ pounds/million BTU}$$

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